1. Title of the Invention

LIQUID CRYSTAL DISPLAY DEVICE

2. Scope of Claims

(1) A liquid crystal display device, in which a plurality of liquid crystal driving elements are arranged in a matrix on a substrate of a display panel, the perimeter of a glass electrode plate with a transparent electrode attached thereto is stuck to the opposite surface of the substrate to form a given gap between the substrate and the glass electrode plate and place liquid crystal material in the gap, characterize in that: a post having a height corresponding to a desired gap is formed on the liquid crystal display elements by an electric insulator, and the substrate and the glass electrode plate are set at a desired gap by the post.

(2) The liquid crystal display device of claim 1, characterized in that: the electric insulator performs a light shielding in the liquid crystal driving elements.

(3) The liquid crystal display device of claim 1, wherein the liquid crystal driving element is a thin film transistor comprising a gate electrode, source and drain electrodes, an insulating film formed in contact with the gate electrode and a semiconductor layer formed in contact with the insulating film, both ends being in contact with the source and drain electrodes.

(4) The liquid crystal display device of claim 1, wherein the electric insulator is a synthetic resin material formed at a predetermined position by a photolithography process.

3. Detailed Explanation of the Invention

Techical Field

The present invention relates to a image display device using liquid crystal and a thin film transistor (hereinafter, a TFT), and its objective is to control a gap between a glass plate having a transparent electrode stuck to one peripheral surface and a TFT substrate at a good accuracy and attempt to shield light to the TFT.

Background Art

In recent years, thin display devices as a display device substituting a conventional CRT have been actively developed. Among the thin display devices, a liquid crystal display device exceeds other types of devices in the aspect of power, driving voltage and lifespan, and is greatly expected as a future display device. Generally, liquid crystal display devices are classified into a dynamic drive type and a static drive type. The latter is excellent in the aspect of power and driving voltage. The static drive type liquid crystal display device generally comprises an upper glass substrate and a lower semiconductor integrated circuit substrate, and displays characters, graphs or images by selecting a liquid crystal driving element arranged in a matrix on the semiconductor integrated circuit as an external selection circuit, and applying a voltage to the liquid crystal. Recently, there have been made studies of a liquid crystal display device in which the semiconductor integrated circuit is formed as a TFT not on a semiconductor substrate but on an insulating substrate having a superiority in terms of large surface area and low cost. A general circuit diagram thereof will be shown in FIG.1.

FIG.1(a) is one portion of a matrix type arrangement view of liquid crystal driving elements (pixels) formed as TFTs on an insulating substrate used for a static drive type liquid crystal display panel. The region surrounded by 1 of the drawing is a

display region, wherein pixels 2aa, 2ab, 2ba, and 2bb are arranged in a matrix format. 3a and 3b represent a video signal line to the pixels, and 4a and 4b represent a timing signal line to the pixels. FIG.1(b) shows a circuit diagram of one pixel, especially, an equivalent circuit diagram for the pixel 2aa. A data signal is maintained in a condenser 6 by a switching transistor 5. The data signal is applied as an electric field to liquid crystal 7 by a common electrode 72 formed on a glass panel facing a liquid crystal driving electrode 71 corresponding to each of the pixels on the insulating substrate, and thereby generates a contrast. Generally, in case of utilizing this liquid crystal display panel for a image display purpose (for use in a television), timing is applied to each scan line by linear sequential scanning, and a signal voltage is maintained in the condenser corresponding to each of the pixels. In case of utilizing the liquid crystal display panel for a television, the response of liquid crystal is fine, and a relatively good image can be acquired.

FIG.2(a) shows a plane view of a unit pixel as shown in FIG.1(b) integrated in a circuit on the glass plate by a TFT. For example, a liquid crystal display device in which the dimension of the unit pixel is 220μm×165μm. The TFT 5 is comprised of a source 202, a drain 203 and a gate 204. An ITO (Indium Tin Oxide) 208 forms a condenser 6 along with a common base ITO 206 through a thin silicon oxide film 207.

FIG.2(b) is a cross sectional view taken along line X-X' of FIG.2(a). FE-TN liquid crystal or G-H liquid crystal 7 or G-H liquid crystal 7 is charged between a glass substrate 21 with a TFT 1 and a glass substrate 22 with a transparent electrode 23 stuck to one peripheral surface, thereby forming a liquid crystal cell.

Light 10 incident from the top portion of the glass substrate 22 passes through the liquid crystal 7 only in one direction for vibrating light by a deflector plate 25, and

passes through the glass substrate 21 and a deflector plate 24. An electric field is applied to the liquid crystal and liquid crystal molecules are twisted by applying a desired potential between an ITO 23 and an ITO 208, and the transparency for the liquid crystal 7 of the light 10, thereby obtaining a transmission type liquid crystal display device.

FIG.3 shows the glass substrate 21 of FIG.2(b) where the above circuit with a TFT, condenser, etc. integrated thereto is cut, and a given gap 13 is disposed between the glass substrate 22 with a transparent electrode 23 stuck to one peripheral surface and the glass substrate 21 by using spacers 11. The gap 13 is sealed with liquid crystal 7. By a sealant 12 made of a suitable resin, the discharge of liquid crystal is prevented and the penetration of moisture is avoided.

In such a type of a display device, a cut glass substrate 21 has a large dimension of 44mm×56mm while it has a thickness no more than 1mm. Thus, a deviation generated in a thermosetting process of the sealant 12 causes bending of the glass substrate 21 after thermosetting even if assembling is started with the glass substrate 21 not bent, and causes the center of the glass substrate 21 approach to the glass substrate 22, as shown in FIG.3(a), or be spaced therefrom as shown in FIG.3(b).

The gap 13 is only 5~10μm in dimension, thus it is very hard to control deviation generated in a thermosetting process. Because the gap 13 is a gap of the liquid crystal 7, a change in the gap 13 causes a change in electric field strength applied to the liquid crystal 7, and this results in a change in the response speed or transparency of the liquid crystal. Thus, the uniformity of images is sharply reduced, and in extreme cases, liquid crystal may not be twisted at the center part of the screen. It is inevitable that the glass substrate where the integration circuit is formed by the TFT is bent more or less,

and in this case, a cross section, not of such a simple shape as shown in FIG.3 but of a more complicated shape, is created, thereby making the non-uniformity of both surfaces to have a moiré pattern.

Anyway, it is considerably hard to stick the large glass substrate 21 of no less than 44mm×56mm to the glass substrate 22 only with the spacers 11 arranged only in peripheral parts. Thus, glass fibers are finely cut to several tens of μm and dispersed on the surface of the glass substrate 21 at a proper density and used as a substitute for the spacers, and the technique of sealing the glass substrates 21 and 22 with a sealant while applying pressure thereto is attempted. The glass fibers have a small difference in their diameter, and even in the case that they are actually applied to assembling, the uniformity of images is sharply improved, and the operating state of the liquid crystal is extremely uniform too.

However, black and white are reversed by a potential given to the ITO 23 a great deal of point defects and line defects are created and picture quality is deteriorated in a difference sense from the conventional art to lower an assembly yield. This is because as shown in FIG.4, in the process of pressing and sealing the glass fibers 31 dispersed on the glass substrate as spacers, a thin oxide film 207 for a condenser is destroyed from the ITO 208 and is dispersed here and there on the lines of a source 202 and a gate 204, thereby cutting the lines. If the shape of the glass fibers 31 has a shorter or the same diameter, the pressure on applying pressure to the glass fibers and sealing them is made uniform and has a less probability of being disposed on the lines. But, in reality, it is assumed that the occurrence of the aforementioned defects is inevitable since there is a limitation on the cut length of the fibers and there is a difference in diameter. It can be easily presumed that although if the fibers themselves are soft, the

above destruction caused from the collapse of the fibers may be avoided, but this cannot guarantee a better accuracy of the gap 13.

[Object of the Invention]

For these reasons, the present inventors had to give up the idea of introducing the control of a gap 13 by glass fibers. The point of this invention is a result of devising a material and shape which do not disturb the arrangement of liquid crystal molecules and destroy an integrated circuit utilizing a TFT. Hereinafter, an embodiment of the present invention will be described with reference to FIG.5.

[Construction of the Invention]

First, as for the shape of spacers, it is preferable to contact with an integrated circuit by a line or point like a cylinder or sphere since a pressure per unit area of contact points becomes larger, and more of a contact area is required. Next, as for the arrangement of spacers, in the technique of scattering spacers on an integrated circuit, they are disposed on an ITIO at a probability that however small the spacers are, they exist. Of course, sine liquid cannot exist there, the transmittance of light using liquid crystal cannot be controlled. Further, the flow of liquid crystal is disturbed, smear is generated in the orientation state of liquid crystal, thereby leading to the deterioration of picture quality along with the aforementioned phenomenon. Therefore, the arrangement which avoids the ITO top is required. Such a selective arrangement cannot help but depends on a photography process utilizing photosensitive resin. Finally, as for the material of the spacers, even if the spacers are wrongly arranged on a TFT integrated circuit or there is a crack or pinhole in an oxide film on the integrated circuit, the spacers have to be electrically insulating so that a transparent electrode may not be shorted with a metal line or semiconductor layer.

As a result of considering the above, in the present invention, as shown in FIG.5, a columnar electric insulator 41 is stuck and formed selectively higher than the ITO 208 in an area except the ITO 208. A cross section contacting the glass substrate 22 of the electric insulator 41 is not necessarily limited to a rectangular shape as shown in FIG.5.

As electric insulating materials used for the TFT integrated circuit, a silicon oxide film, a silicon nitride film, etc. formed by CVD (chemical vapor deposition) can be used. Considering that the required thickness of the columnar spacers 41 is 5~10μm, it is expected there may be considerable technical difficulties in the uniformity of their thickness and their etching direction.

[Embodiment]

In order to avoid the above problems, an embodiment of this invention aims at and employs polyimide resin. Polyimide is an organic polymer and a liquid having a high viscosity, is cured by heat treatment of 200~800°C called curing, and has superior heat resistance, moisture resistance and electric insulation property after curing. Further, polyimide is capable of treatment of photosensitive resins because it is capable of rotational application by a spinner and is easily ashed by oxygen gas plasma, and polyimide is widely used as a passivation or multilayer wire in the integrated circuit. Besides, it also turns out that polyimide does not melt in liquid crystal after heat curing. Thus, after forming a source 202 and a drain 208, polyimide is applied thickly to several μm on the whole surface, left selectively in a prescribed area on a TFT except the ITO208, heat-cured and the columnar insulator 41 is obtained. In order to selectively leave polyimide, a photography process utilizing photosensitive resin is carried out, or

photosensitive polyimide is used. Further, insulating resin having the same property as polyimide can be used for the present invention.

Meanwhile, it is often the case that if external light is incident directly on the TFT surface, a light conducting effect is generated in a semiconductor layer 205, and a change in waveform or a change in voltage is caused when transmitting various kinds of signals by the TFT, thereby failing to maintain normal device characteristics. However, by forming the columnar electric insulator 41 on the TFT, a light shielding effect to a channel area in a semiconductor layer 205 formed by the source 202 and the drain 208 is performed simultaneously, and an effect for reducing a leak current by a light by one digit or more is also generated.

[Effect of the Invention]

As apparently explained above, in the present invention, there is no orientation smear or the destruction of the integrated circuit at all as compared to a conventional spacer material, and an assembly yield of a process for sticking a glass substrate on which a TFT is formed and another glass substrate is almost 100%, by placing a lot of insulating columnar substances on the TFT, and constituting them as a spacer. Moreover, a light shielding effect of the TFT can be performed simultaneously, and an a leak current by light can be reduced greatly.

4. Brief Explanation of the Drawings

FIG.1(a) is a matrix arrangement view of a liquid crystal display device.

FIG.1(b) is an equivalent circuit diagram for one liquid crystal display pixel.

FIG.2(a) is a plane view of a unit pixel in the device of FIG.1.

FIG.2(b) is a cross sectional view taken along line X-X' of FIG.2(a).

FIGs.3(a) and 3(b) are cross sectional views in which a glass substrate formed by a conventional method and a glass substrate with a TFT are sealed.

FIG.4 is a cross sectional view showing a state in which glass fibers destroyed the TFT.

FIG.5 is a cross sectional view of one embodiment of a liquid crystal display device based on the structure according to the present invention.

5 : TFT

6 : condenser for integration

7 : liquid crystal

21 : glass substrate

206 : ITO

207 : oxide film

208 : ITO

22: opposite glass substrate

23 : ITO

41 : columnar electric insulator